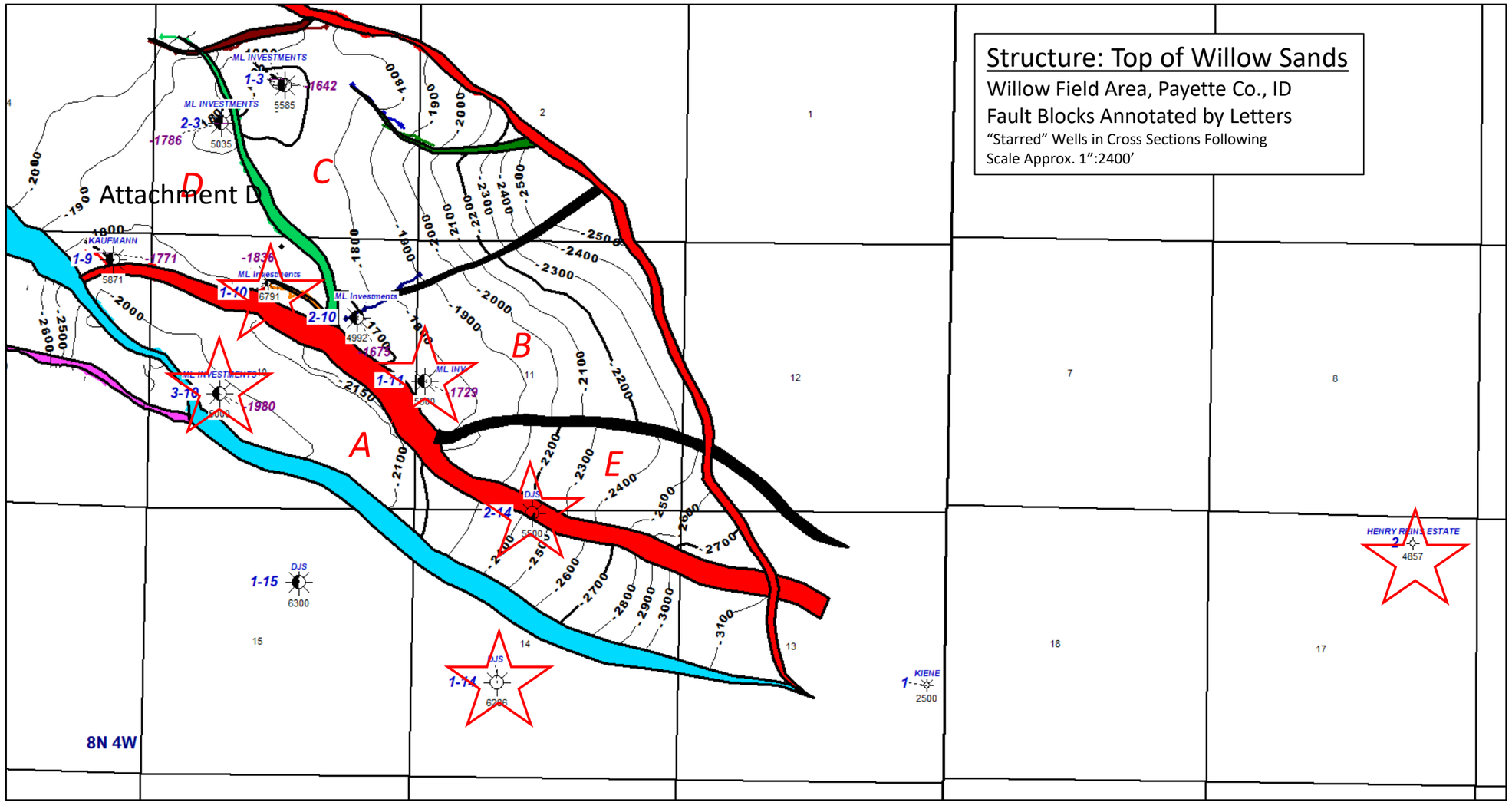
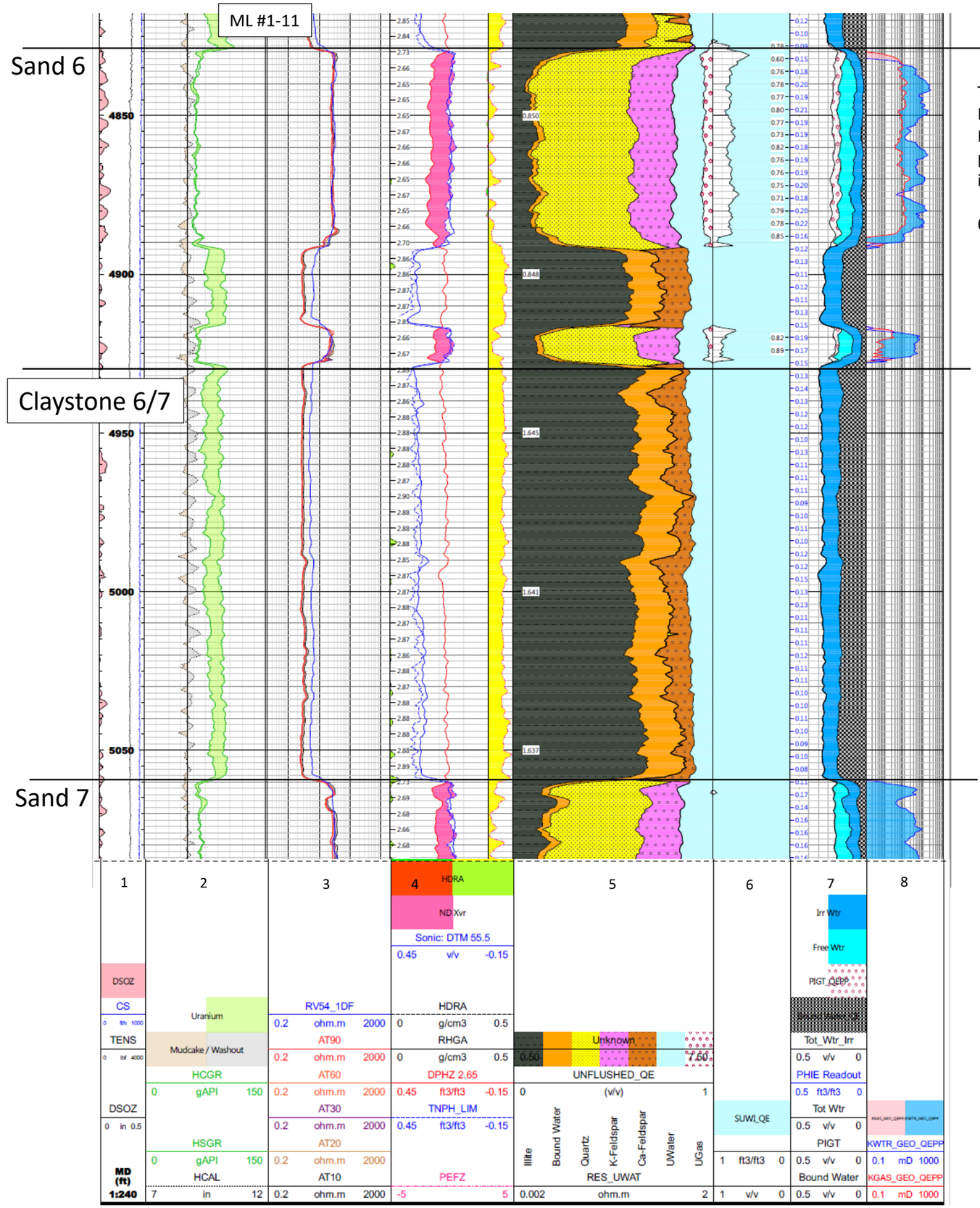
SROG Responses to EPA Questions 1 & 2 of October 29, 2020
Attachment D

Proposed Injection Well: 1. Lower Confining Zone
2. Depth to Injection Interval

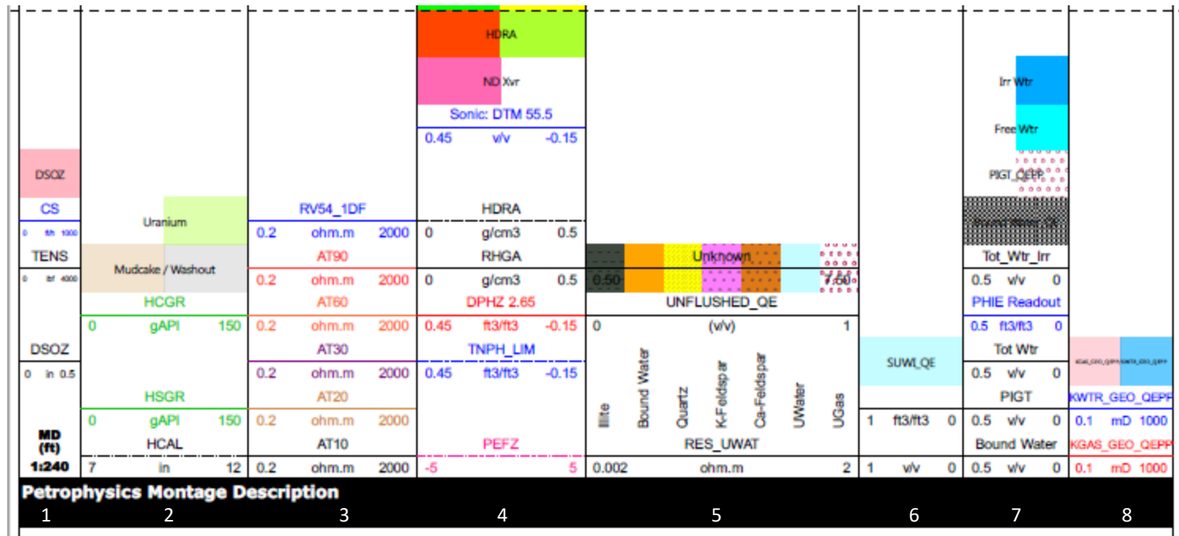




ELAN Processed Log of Claystone 6/7 Lower Confining Zone

2

The ELAN Log incorporates multiple measured physical properties from the wellbore, including spectral gamma ray, RT Scanner (vertical and horizontally focused electrical induction curves with depths of investigation from 10 to 90 Inches), as well as density, neutron and sonic derived porosity values. These inputs are used to create the petro-physical interpretation shown (left). The log for the 6/7 Claystone Zone (4930' to 5060' MD) is on the left, the right image (below) is of the log "footer" with descriptions of the data presented in each track. Note specifically track 8, which shows that the permeability of the 6/7 Claystone Zone is less than 0.1 millidarcies over the entire 130' thick 6/7 Claystone zone. Actual values calculated average 0.0002 to 0.0007 md.



Track 1: Depth
Depth Scale is 1:240 (5" Log).
Cable Tension.
DSOZ Computed Density Standoff (Shaded).
CS Cable Speed.

Track2: Correlation
GR with shading > 150 GAPI.
SP where available.
Caliper and Bitsize, shaded for mudcake and washout.
Spectral GR, Uranium, Potassium and Thorium when available.
HCGR is K+Th, delta to HSGR is Uranium.

Track 3: Resistivity Induction
AT90 - AT10, Induction resistivities with 10, 20, 30, 60 and 90 inch DI.
RXO from Density pad or HRLT where available.
RV54: 54 inch DI vertical resistivity from RT Scanner where available.

Track 4: Porosity
TNPH - Thermal neutron porosity.
DPHZ - Density porosity.
Crossover shaded when TNPH<DPHZ.
Sonic Porosity when available.
PEF - Photoelectric cross section.
HDRA - Density correction with baseline noted and shading.
RHGA - apparent grain density from ELAN model as readout value.

Track 5: ELAN Volume Solution
Volumes as indicated for volumes noted in header 0 - 100% volume display.
RW used in saturation calculation as readout.

Track 6: Water Saturation
Unflushed water saturation with readout where SW<1.
Total Gas from Mudlog for correlation.

Track 7: Porosity / Fluids Display
PIGT Total porosity with HC shading to Water Volume.
Irreducible Water Volume from Elan is dark blue shading to Free Water.
Free water is light blue shading.
Bound Water from ELAN with gray shading.
PIGE Porosity readout where PIGE>0.02.

Track 8: Relative Permeability
Rel perms to water and gas. Shading where preferential fluid will flow.

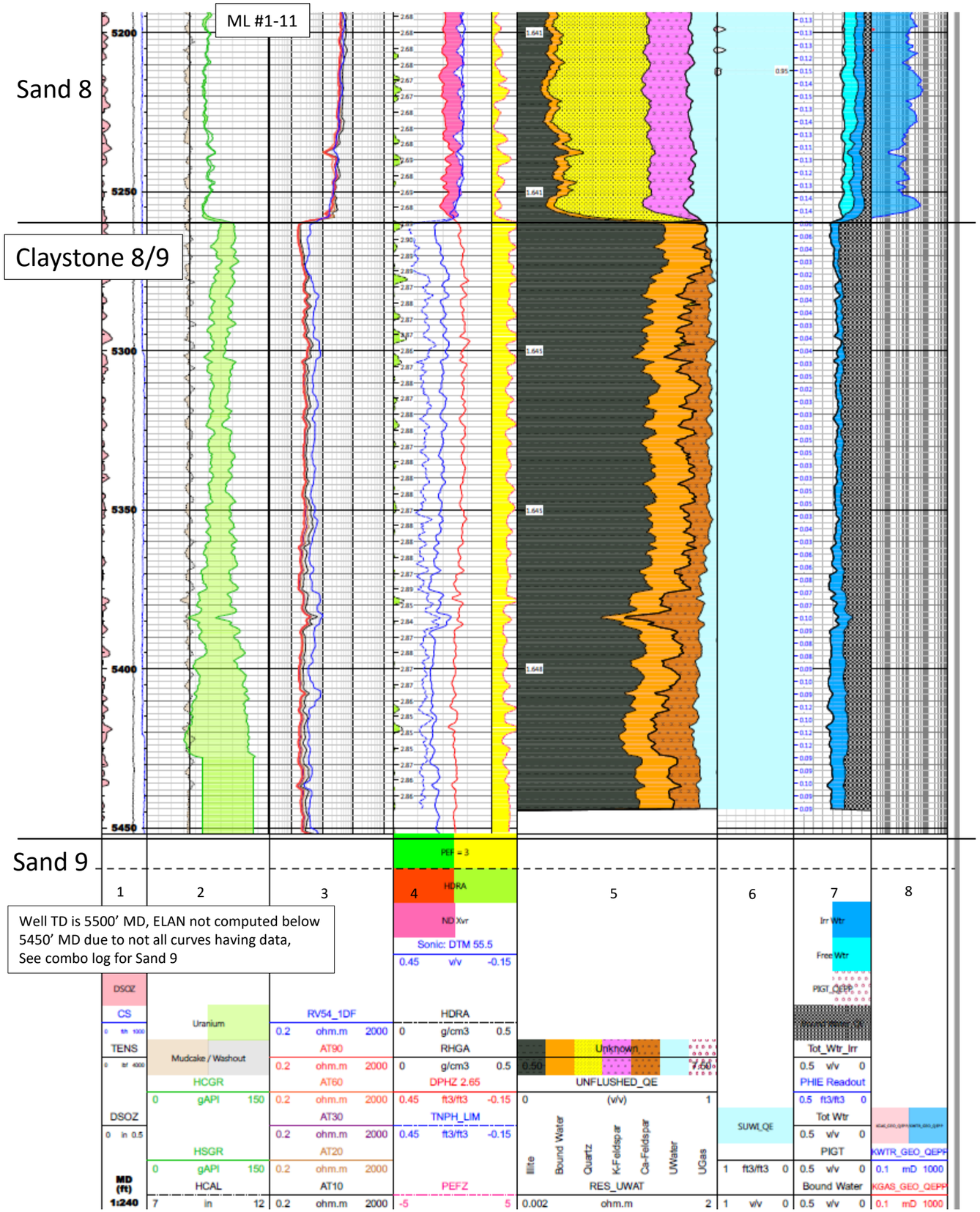
COMPANY:	Alta Mesa Services, LP
WELL:	ML Investments 1-11
FIELD:	Willow
COUNTY:	Payette
STATE:	Idaho
COUNTRY:	USA

Schlumberger

API No.: 11-075-20025-0000

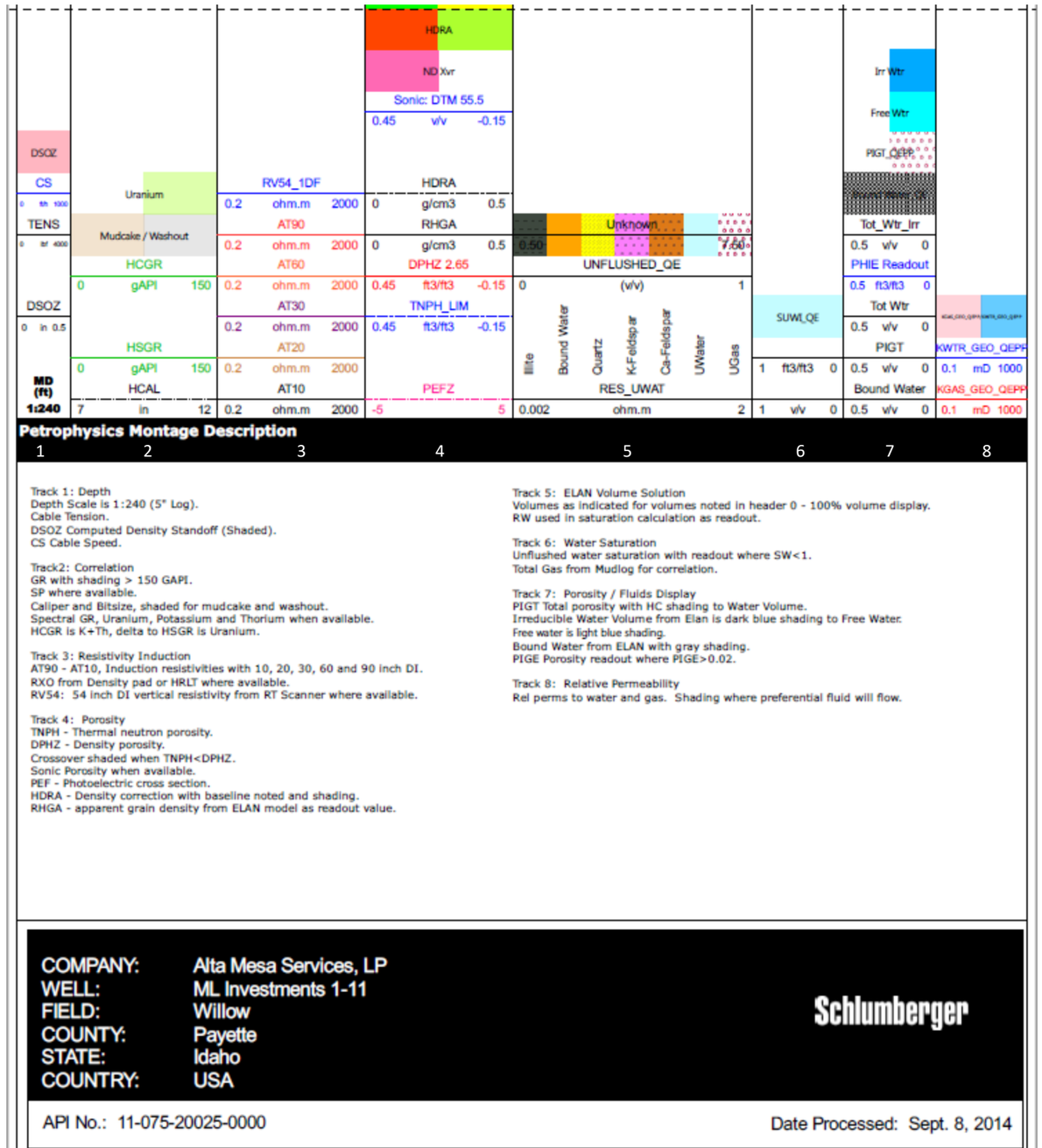
Date Processed: Sept. 8, 2014

ELAN Processed Log of Claystone 8/9 Lower Confining Zone



Well TD is 5500’ MD, ELAN not computed below 5450’ MD due to not all curves having data, See combo log for Sand 9

The ELAN Log for the 8/9 Claystone Zone is on the left (5260’ to 5452’ MD). The right image (below) is of the log “footer” with descriptions of the data presented in each track. As seen on the previous slide, Note specifically track 8, which shows that the Permeability of the 8/9 Claystone Zone is less than 0.1 millidarcies over the entire 192’ thick claystone zone. Actual values calculated average 0.000002 to 0.000005 millidarcies.



Track 1: Depth
Depth Scale is 1:240 (5" Log).
Cable Tension.
DSOZ Computed Density Standoff (Shaded).
CS Cable Speed.

Track2: Correlation
GR with shading > 150 GAPI.
SP where available.
Caliper and Bitsize, shaded for mudcake and washout.
Spectral GR, Uranium, Potassium and Thorium when available.
HCGR is K+Th, delta to HSGR is Uranium.

Track 3: Resistivity Induction
AT90 - AT10, Induction resistivities with 10, 20, 30, 60 and 90 inch DI.
RXO from Density pad or HRLT where available.
RV54: 54 inch DI vertical resistivity from RT Scanner where available.

Track 4: Porosity
TNPH - Thermal neutron porosity.
DPHZ - Density porosity.
Crossover shaded when TNPH<DPHZ.
Sonic Porosity when available.
PEF - Photoelectric cross section.
HDRA - Density correction with baseline noted and shading.
RHGA - apparent grain density from ELAN model as readout value.

Track 5: ELAN Volume Solution
Volumes as indicated for volumes noted in header 0 - 100% volume display.
RW used in saturation calculation as readout.

Track 6: Water Saturation
Unflushed water saturation with readout where SW<1.
Total Gas from Mudlog for correlation.

Track 7: Porosity / Fluids Display
PIGT Total porosity with HC shading to Water Volume.
Irreducible Water Volume from Elan is dark blue shading to Free Water.
Free water is light blue shading.
Bound Water from ELAN with gray shading.
PIGE Porosity readout where PIGE>0.02.

Track 8: Relative Permeability
Rel perms to water and gas. Shading where preferential fluid will flow.

COMPANY:	Alta Mesa Services, LP
WELL:	ML Investments 1-11
FIELD:	Willow
COUNTY:	Payette
STATE:	Idaho
COUNTRY:	USA

Schlumberger

API No.: 11-075-20025-0000

Date Processed: Sept. 8, 2014

ELAN Log Comparison to Quad Combo Log – ML #1-11

ML #1-11
Quad Combo Log

ML #1-11
ELAN Log

SAND

1/2 Clay

2/3 Clay

3/4 Clay

4/5 Clay

5/6 Clay

Lower Confining Zone

6/7 Clay

7/8 Clay

Redundant
Lower Confining Zone

8/9 Clay

Sand 1

Sand 2

Sand 3

Sand 4

4/5 Clay

Sand 5

5/6 Clay

Sand 6

6/7 Clay

Sand 7

Sand 8

8/9 Clay

STRATIGRAPHIC CROSS-SECTION

ML #1-11 & DJS #2-14 Wells

DATUM: Sand 3 top

NORTHWEST

SOUTHEAST

5

ML #1-11

DJS #2-14

Basalt Sill

Massive Chalk Hills Claystone

Massive Chalk Hills Claystone

"Red" Fault cuts #2-14 well at 4790' MD, Approx. 150' of section is "Faulted Out" (Sd 1 & Upper part of Sd 2 are Faulted Out)

1/2 Clay

2/3 Clay

DATUM: Sand 3 Top

3/4 Clay

4/5 Clay

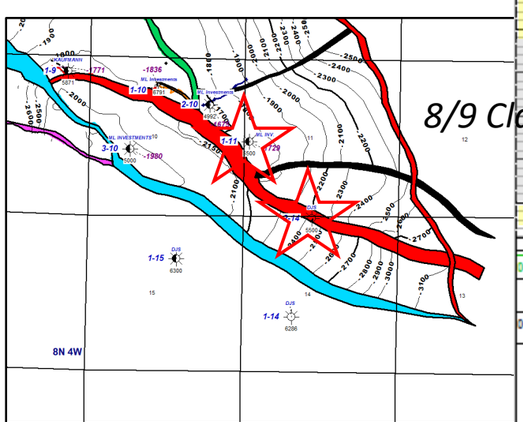
5/6 Clay

6/7 Clay

7/8 Clay

8/9 Clay

Total Depth of Well 5500'



NOTES:

1. **Sands** are **YELLOW** and numbered
2. **Claystones** are **GRAY** and annotated by the bounding sands' names above & below
3. Observe that Claystones have large Neutron/Density porosity value separations, due to the large amount of bound water in the claystones, resulting in high apparent porosity of the neutron curve values (Neutron porosity values are blue curve, Density porosity curve is red)
4. As the sands are predominately clean quartz, the density and neutron porosity values tend to track each other closely in the sands
5. The 2 wells are 3352' apart

STRATIGRAPHIC CROSS-SECTION

ML #1-11 & DJS #2-14 Wells

DATUM: Sand 3 top

Section shows deeper stratigraphy

ML #1-11

DJS #2-14

Basalt Sill

Massive Chalk Hills Claystone

Massive Chalk Hills Claystone

"Red" Fault cuts #2-14 well at 4790' MD, Approx. 150' of section is "Faulted Out" (Sd 1 & Upper part of Sd 2 are Faulted Out)

1/2 Clay

2/3 Clay

DATUM: Sand 3 Top

2/3 Clay

3/4 Clay

3/4 Clay

4/5 Clay

4/5 Clay

5/6 Clay

5/6 Clay

Total Depth of Well 5500'

6/7 Clay

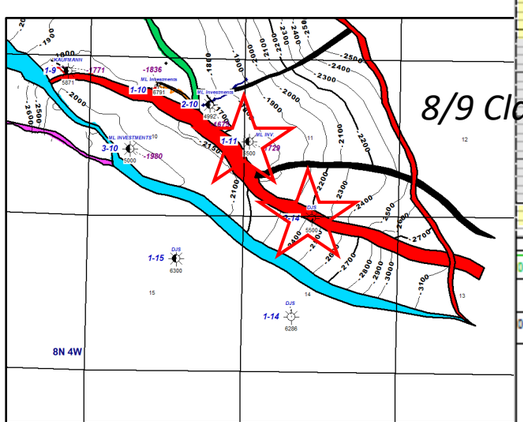
6/7 Clay

7/8 Clay

7/8 Clay

8/9 Clay

8/9 Clay



Stratigraphy of section below 5500' TD in #2-14 from area wells and 3-D Seismic data, and honoring the fact that the Claystone units are Lacustrine deposits covering widespread areas, are highly correlative, And present in all deep wells surrounding the DJS #2-14.

ML #1-11

DJS #2-14

ML #3-10

Basalt Sill

Massive Chalk Hills Claystone

+/- 150' of Section Faulted Out

Sand 1

Sand 2

1/2 Clay

2/3 Clay

DATUM: Sand 3 Top

3

4

3/4 Clay

4/5 Clay

5

5/6 Clay

6

6/7 Clay

7

7/8 Clay

8

8/9 Clay

9

1

2

3

4

5

6

7

8

9

1/2 Clay

2/3 Clay

3/4 Clay

4/5 Clay

5/6 Clay

6/7 Clay

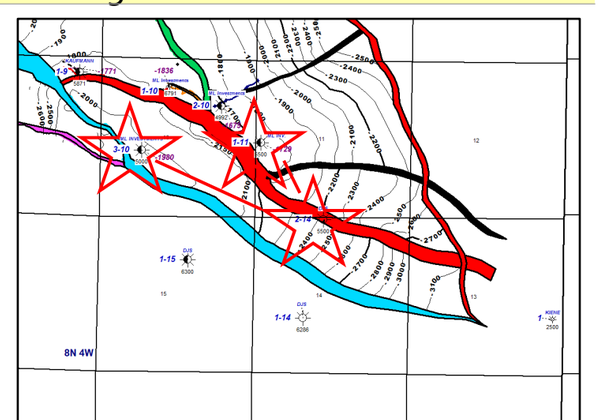
8/9 Clay

Stratigraphy of section below 5500' TD in #2-14 inferred from area wells and 3-D Seismic data, and honoring the fact that the Claystone units are Lacustrine deposits covering widespread areas and are highly correlative, And present in all deep wells surrounding the DJS #2-14.

STRATIGRAPHIC CROSS-SECTION

ML #1-11, DJS #2-14 and ML #3-10 Wells

DATUM: Sand 3 top



NORTHWEST

Fault Block "B"

ML 1-11
Elev. KB: 2403.4'
GR & Induction Logs

Massive Chalk Hills Claystone

Fault Block "E"

Fault Block "A"

DJS 2-14
Elev. KB: 2502'
GR & Induction Logs

SOUTHEAST

Fault Block "A"

8

DEPTH (Subsea)

DEPTH (Subsea, ft)

-1700'

-2000'

-2500'

-3000'

WILLOW FIELD

GAS/COND. RESERVOIRS

Orig. Gas/Water @ -1888'

Note: Sands 1 &2 are probably Gas/Cond. Productive in this Fault Block "E" from Seismic HCI'S & BOTH Neighboring Fault Blocks Are HYDROCARBON PRODUCTIVE

Basalt Sill

Note that Sands 1 & 2 are Gas/Cond. Productive in ML 3-10 Well in this Fault Block "A" with Lowest Known Gas @ -2072'

Sand 1
1/2 Claystone
Sand 2
2/3 Claystone
Sand 3
3/4 Claystone
Sand 4
4/5 Claystone
Sand 5
5/6 Claystone
Sand 6
6/7 Claystone
Sand 7
Sand 8
8/9 Claystone
Sand 9
9/10 Claystone

STRUCTURAL CROSS-SECTION B-E

Willow Sands & Claystones

Willow Field, Payette Co., Idaho

Horiz. Scale 1"=400' Datum: Sea Level
Vert. Scale 1"= 200' Dec., 2020
Vert. Exag.= 2 to 1 D. Smith

NOTES:

1. **Sands** are **YELLOW** and numbered
2. **Claystones** are **GRAY** and annotated by the bounding sands' numbers above & below
3. **Known Gas Reservoir in Fault Block "B"** has Gas/Water contact @ -1888' subsea
4. **Probable Gas Reservoir in Fault Block "E"** has predicted Gas/Condensate Accumulation
5. **Known Gas Reservoir in Fault Block "A"** (ML 3-10 well) is located "Updip" in this fault block

NORTH

Fault Block "B"

DEPTH (Subsea)

-1700'

WILLOW FIELD

GAS/COND. RESERVOIRS

-2000'

-2500'

-3000'

ML 1-11
Elev. KB: 2403.4'
GR & Induction Logs

Massive Chalk Hills Claystone

Sand 1

1/2 Claystone

Sand 2

Orig. Gas/Water @ -1888'

2/3 Claystone

Sand 3

3/4 Claystone

Sand 4

4/5 Claystone

Sand 5

5/6 Claystone

Sand 6

6/7 Claystone

Sand 7

Sand 8

8/9 Claystone

Sand 9

9/10 Claystone

1 2 3 4 5 6 7 8 9

Fault Block "E"

Fault Block "A"

DJS 2-14
Elev. KB: 2502'
GR & Induction Logs

Note: Sands 1 &2 are probably Gas/Cond. Productive in this Fault Block "E" from Seismic HCI'S & BOTH Neighboring Fault Blocks Are HYDROCARBON PRODUCTIVE

Massive Chalk Hills Claystone

Sand 1

Sand 2

1/2 Claystone

2/3 Claystone

Sand 3

3/4 Claystone

Sand 4

4/5 Claystone

Sand 5

5/6 Claystone

Sand 6

6/7 Claystone

Sand 7

Sand 8

8/9 Claystone

2 3 4 5 6

Fault Block "A"

Basalt Sill

-1700'

-2000'

Massive Chalk Hills Claystone

Note that Sands 1 & 2 are Gas/Cond. Productive in ML 3-10 Well in this Fault Block "A" with Lowest Known Gas @ -2072'

-2500'

-3000'

1 2 3 4 5 6 7 8

3/4

4/5

2/3 Claystone

3/4 Claystone

5/6 Claystone

4/5 Claystone

6/7 Claystone

6/7 Claystone

5/6 Claystone

6

6/7 Claystone

7

8

8/9 Claystone

Fault Block "E"

Fault Block "A"

DJS 1-14
Elev. KB: 2606'
GR & Induction Logs

SOUTH

9

-1700'

DEPTH (Subsea, ft)

-2000'

-2500'

-3000'

Basalt Sill

Basalt Sill

Sand 5

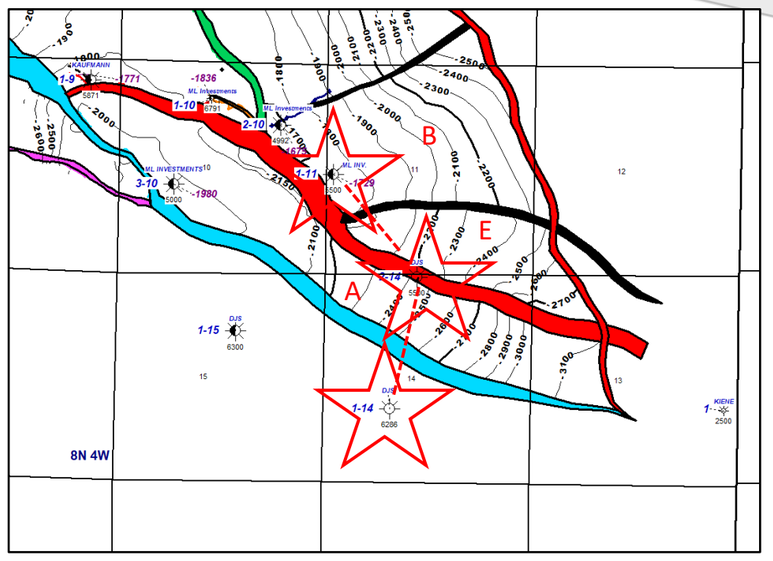
Sand 6

Sand 7

Sand 8

Basalt Sill

Fault Block "B"



STRUCTURAL CROSS-SECTION B-E-A

Willow Sands & Claystones

Willow Field, Payette Co., Idaho

Horiz. Scale 1"=640' Datum: Sea Level

Vert. Scale 1"= 300' Dec., 2020

Vert. Exag.= 2.2 to 1 D. Smith

WEST

ML #1-11

3.74 Miles Between Wells

Reins #2

EAST

Massive Chalk
Hills Claystone

Sand 1

1/2 Clay

Sand 2

2/3 Clay

DATUM: Sand 3 Top

3

3/4 Clay

4

4/5 Clay

5

5/6 Clay

6

6/7 Clay

7

7/8 Clay

8

8/9 Clay

9

1/2 Clay

2/3 Clay

3

4

5

6

6/7 Claystone

7

8

Sand 3

3/4 Clay

Sand 4

4/5 Clay

Sand 5

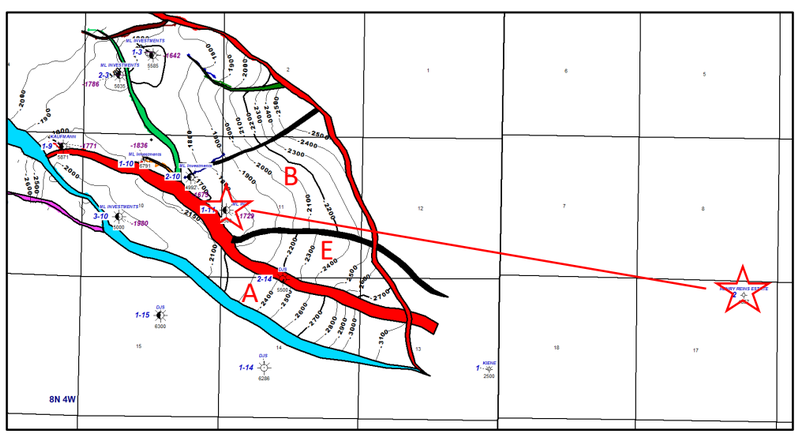
5/6 Clay

Sand 6

6/7 Clay

Proposed Injection Zone

Claystone Interval
With multiple thin sands



STRATIGRAPHIC CROSS-SECTION

ML #1-11 & REINS #2 Wells
DATUM: Sand 3 top

STRATIGRAPHIC CROSS-SECTION

ML #1-10 & ML #1-11 Wells
DATUM: Top Sand 3
Section shows deeper stratigraphy

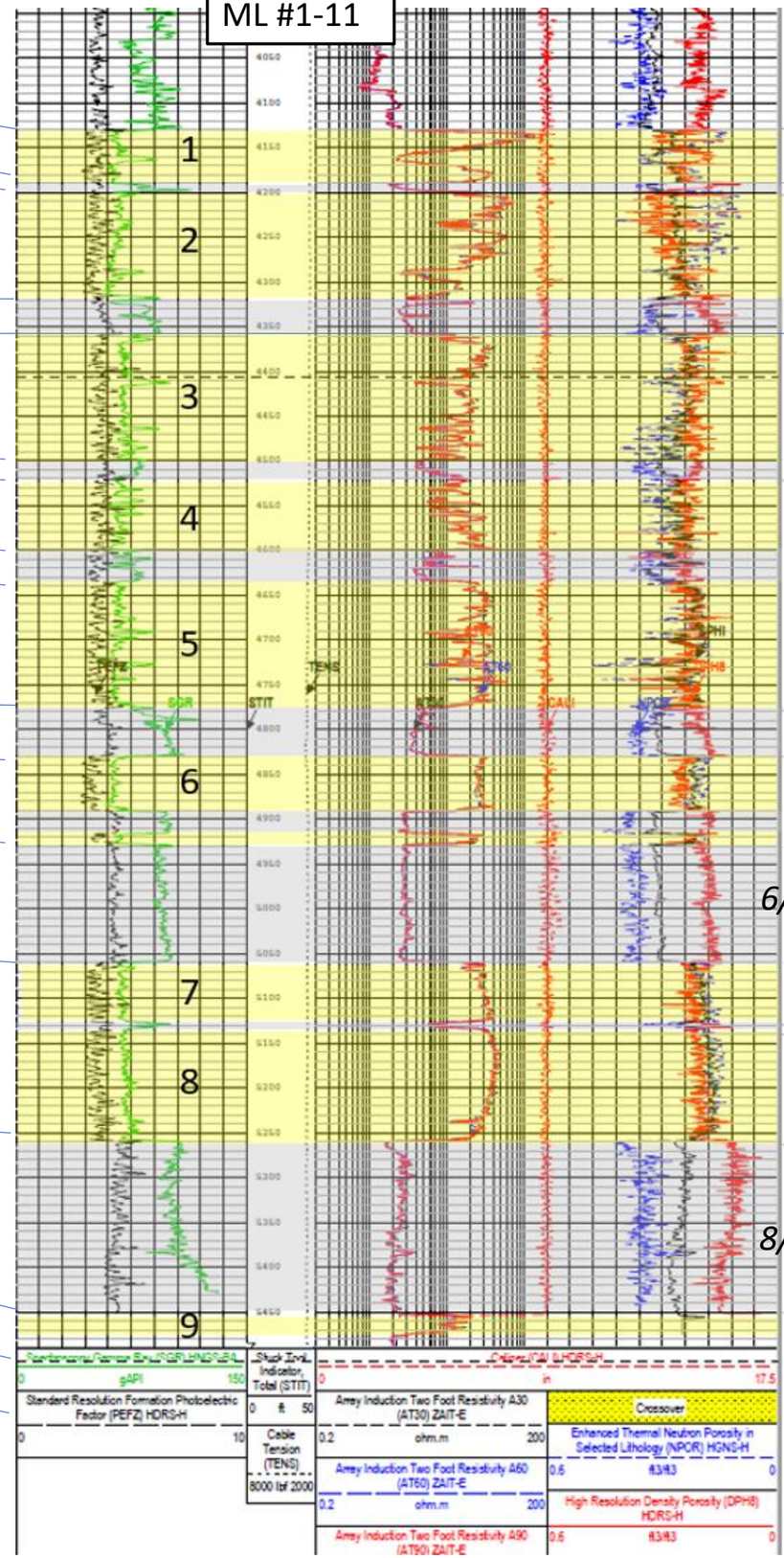
ML #1-10

Sand 1
Sand 2
2/3 Claystone
Datum: Top Sand 3
Sand 3
3/4 Claystone
Sand 4
4/5 Claystone
Sand 5

"Green Fault" cuts out
+/- 150' of Missing Section,
Most of Sand 5

5/6 Claystone
Sand 6
6/7 Claystone
Sand 7
Sand 8
8/9 Claystone
Sand 9
9/10 Claystone
Sand 10

ML #1-11



NORTHWEST

Fault Block "B"

ML 1-11
Elev. KB: 2403.4'
GR & Induction Logs

Massive Chalk Hills Claystone

Fault Block "E"

Fault Block "A"

DJS 2-14
Elev. KB: 2502'
GR & Induction Logs

SOUTHEAST

Fault Block "A"

12

DEPTH (Subsea)

DEPTH (Subsea, ft)

-1700'

WILLOW FIELD

GAS/COND. RESERVOIRS

Sand 1

1/2 Claystone

Sand 2

Orig. Gas/Water @ -1888'

Note: Sands 1 &2 are probably Gas/Cond. Productive in this Fault Block "E" from Seismic HCI'S & BOTH Neighboring Fault Blocks Are HYDROCARBON PRODUCTIVE

Basalt Sill

-2000'

2/3 Claystone

Sand 3

3/4 Claystone

Sand 4

4/5 Claystone

Sand 5

5/6 Claystone

Sand 6

6/7 Claystone

Sand 7

Sand 8

8/9 Claystone

Sand 9

9/10 Claystone

Top of Injection Zone @ Shallowest Point (-2180')

PROPOSED INJECTION ZONE

Base of Injection Zone @ Shallowest Point (-2860')

-2100'

-2200'

-2300'

-2400'

-2500'

-2600'

-2700'

-2800'

-2900'

-3000'

-3100'

STRUCTURAL CROSS-SECTION B-E

Willow Sands & Claystones

Willow Field, Payette Co., Idaho

Horiz. Scale 1"=400' Datum: Sea Level

Vert. Scale 1"= 180' Dec., 2020

Vert. Exag.= 2.2 to 1 D. Smith

NOTES:

1. **Top of Injection zone (Sand 3 top) is at -2180' at shallowest point**
2. **Top of Injection zone (Sand 3 top) is at 4908' MD (-2406' subsea) in DJS 2-14 well**
3. **Base of injection zone (Sand 6 base) is at -2860' at shallowest point**
4. **Base of Injection zone (sand 6 base) is at 5500' MD (-2998' subsea) in DJS 2-14 well**

NORTH

Fault Block "B"

ML 1-11
Elev. KB: 2403.4'
GR & Induction Logs

Fault Block "E"

Fault Block "A"

DJS 2-14
Elev. KB: 2502'
GR & Induction Logs

EAST

DEPTH (Subsea)

DEPTH (Subsea, ft)

-1700'
-2000'
-2100'
-2200'
-2300'
-2400'
-2500'
-2600'
-2700'
-2800'
-2900'
-3000'
-3100'
-3200'
-3300'
-3400'
-3500'
-3600'
-3700'
-3800'
-3900'
-4000'

WILLOW FIELD GAS/COND. RESERVOIRS

Massive Chalk Hills Claystone

Sand 1
1/2 Claystone
Sand 2
Orig. Gas/Water @ -1888'
2/3 Claystone
Sand 3
3/4 Claystone
Sand 4
5/6 Claystone
Sand 5
Sand 6
6/7 Claystone
Sand 7
Sand 8
8/9 Claystone
Sand 9
9/10 Claystone

Note: Sands 1 &2 are probably Gas/Cond. Productive in this Fault Block "E" from Seismic HCI'S & BOTH Neighboring Fault Blocks Are HYDROCARBON PRODUCTIVE

Top of Injection Zone @ Shallowest Point (-2180')

Base of Injection Zone @ Shallowest Point (-2860')

PROPOSED INJECTION ZONE

Basalt Sill

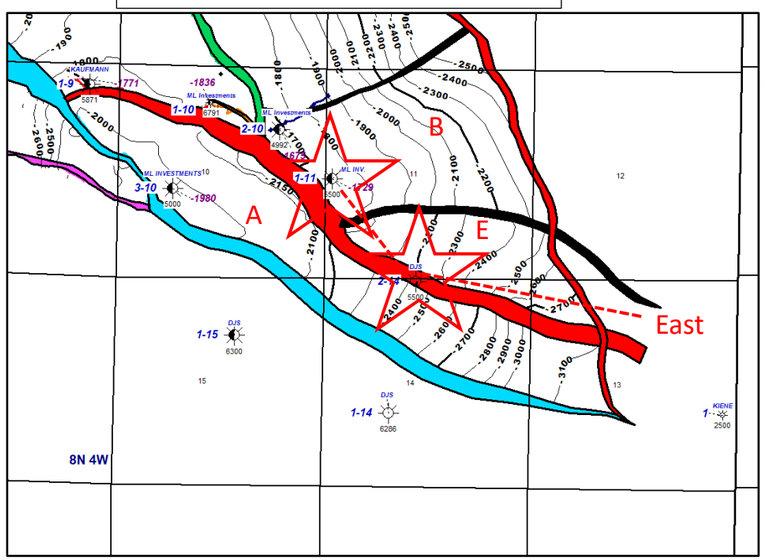
Top of Injection Zone @ Deepest Point (-3090')

Base of Injection Zone @ Deepest Point (-3620')

Fault Block "B"

Fault Block "E"

Index Map: Structure Top Willow Sand 1



STRUCTURAL CROSS-SECTION B-E-EAST

Willow Sands & Claystones

Willow Field, Payette Co., Idaho

Horiz. Scale 1"=640' Datum: Sea Level
Vert. Scale 1"= 300' Dec., 2020
Vert. Exag.= 2.2 to 1 D. Smith

NOTES:

1. **Line of Section is Northwest to Southeast, then bends to the East (See Index Map)**
2. Shallowest and Deepest points of TOP and BASE of Injection Zone are noted on the section
3. **Known Gas Reservoir in Fault Block "B"** has Gas/Water contact @ -1888' subsea
4. **Probable Gas Reservoir in Fault Block "E"** has predicted Gas/Condensate Accumulation
5. 6/7 Claystone is lower confining zone